Outcome of comminuted mandibular fracture repair using an intraoral approach for osteosynthesis

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Abstract: PURPOSE: Traditionally, the treatment of comminuted mandibular fractures involves both closed and open reduction. However, modern treatment principles increasingly tend toward open reduction and internal fixation to shorten oro-functional rehabilitation. Although this method increasingly gained popularity to date, a controversy regarding the extraoral versus the intraoral surgical approach still exists. The current study aimed to objectively evaluate the outcome of comminuted mandibular fracture treatment involving open reduction and internal fixation using an intraoral approach. PATIENTS AND METHODS: Consecutive patients treated at the Department of Cranio-Maxillofacial and Oral Surgery, University Hospital of Zurich, between 2005 and 2012 were included. Demographic, presurgical, perisurgical, and postsurgical data were tabulated and statistically evaluated using the test and the Mann-Whitney U test. RESULTS: Forty-five patients could be included. Excellent postoperative results were seen in 84% (38 patients) of the total cohort. Postoperative complications were seen in 16% (7 patients). These 7 patients had the following complications: wound dehiscence (7% [n = 3]), osteomyelitis (7% [n = 3]), abscess development (4% [n = 2]), bone necrosis (2% [n = 1]), and severe nonocclusion (2% [n = 1]). CONCLUSION: Present data showed that the intraoral approach for open reduction and internal fixation in comminuted mandibular fractures represents a comparable surgical technique regarding fracture repositioning and occlusal rehabilitation. Considerably, the risk of concomitant neurovascular damage or even facial scarring, as demonstrated in the extraoral approach, can be neglected by using this technique. Nevertheless, each case has to be judged on its own accord as to which technique can best treat the underlying fracture.

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Outcome of Comminuted Mandibular Fracture Repair Using an Intraoral Approach for Osteosynthesis

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Purpose: Traditionally, the treatment of comminuted mandibular fractures involves both closed and open reduction. However, modern treatment principles increasingly tend toward open reduction and internal fixation to shorten oro-functional rehabilitation. Although this method increasingly gained popularity to date, a controversy regarding the extraoral versus the intraoral surgical approach still exists. The current study aimed to objectively evaluate the outcome of comminuted mandibular fracture treatment involving open reduction and internal fixation using an intraoral approach.

Patients and Methods: Consecutive patients treated at the Department of Cranio-Maxillofacial and Oral Surgery, University Hospital of Zurich, between 2005 and 2012 were included. Demographic, presurgical, perisurgical, and postsurgical data were tabulated and statistically evaluated using the χ^2 test and the Mann-Whitney *U* test.

Results: Forty-five patients could be included. Excellent postoperative results were seen in 84% (38 patients) of the total cohort. Postoperative complications were seen in 16% (7 patients). These 7 patients had the following complications: wound dehiscence (7% [n = 3]), osteomyelitis (7% [n = 3]), abscess development (4% [n = 2]), bone necrosis (2% [n = 1]), and severe nonocclusion (2% [n = 1]).

Conclusion: Present data showed that the intraoral approach for open reduction and internal fixation in comminuted mandibular fractures represents a comparable surgical technique regarding fracture repositioning and occlusal rehabilitation. Considerably, the risk of concomitant neurovascular damage or even facial scarring, as demonstrated in the extraoral approach, can be neglected by using this technique. Nevertheless, each case has to be judged on its own accord as to which technique can best treat the underlying fracture.

Key Words: Comminuted mandibular fractures, ORIF, intraoral osteosynthesis

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Comminuted mandibular fractures are mainly the result of a high direct or indirect impact to the facial skeleton.[1] Major causes include motor vehicle crashes, work-related injuries, assaults, or sports-related injuries.[2] Frankly, these facial traumas are associated with potentially severe concomitant cerebral or spine injuries and warrant an individualized treatment regimen.

Although general accepted treatment strategies and guidelines exist, many of these clinical and surgical options vary from surgeon to surgeon, leading to some degree of controversy.[3]

The tenant seems to be set in conventional mandibular fracture treatment[4] ; however, there is still a debate regarding the optimal treatment of comminuted mandibular fractures.[5] Different treatment options have been published, ranging from closed to open reduction,[5,6] extraoral or an intraoral approach.[7] Modern treatment principles evidently tend toward rigid internal fixation, as the total rehabilitation time is shorter. However, a controversy regarding the surgical approach exists. Although the extraoral approach inherits significant advantages regarding overview, simplifying fracture reduction, plate positioning, and fixation, it bears considerable risks of damaging important neurovascular and glandular structures, or even visible facial scarring, respectively.[8–12]

This retrospective study was designed to objectively analyze the outcome of comminuted mandibular fracture treatment by an intraoral approach. We hypothesized that this treatment protocol is a comparable alternative to the extraoral approach but inheriting a reduced complication rate while still allowing proper reduction and osteosynthesis.

MATERIALS AND METHODS

This retrospective analysis was performed in concordance with the Federal Swiss Ethical committee (ref: # 035.0001-137). Patients who were consecutively treated at the Department of Cranio-Maxillofacial and Oral Surgery between 2005 and 2012 with comminuted mandibular fractures who underwent open reduction and internal fixation (ORIF) with an intraoral approach were included. Per definition, comminuted mandibular fractures are generally described as at least 4 bone fragments radiologically identified in the same mandibular region.[3,13]

Inclusion criteria were defined as:

(1) The fracture pattern met the aforementioned definition of comminution.
(2) Treatment with ORIF via intraoral approach, and
(3) Sufficient radiological and clinical documentation.

Demographic information was tabulated including patients' age, sex, and diagnosis. Fracture mechanism, location of the fracture, method of treatment, and perioperative and postoperative data were extracted from the hospital information system and coded in Excel (Microsoft Excel). The postoperative interval was at least 12 months.

Data were then analyzed with the statistics program SPSS 21 (IBM SPSS, Chicago, IL). Descriptive statistics such as mean,

standard deviations, medians, interquartile ranges (IQR), and relative frequencies were computed. Associations between 2 discreet variables were investigated by means of a χ^2 test. Differences in medians between 2 groups with respect to continuous variables were analyzed by means of a Mann-Whitney U test. Results of statistical analysis with $P < 0.05$ were considered statistically significant.

Treatment outcome was determined by postoperative complications, trigeminal and facial nerve function, and the ability to establish pretraumatic occlusion. Interincisor gap on the last follow-up and patient's satisfaction were further criteria to evaluate the outcome.

RESULTS

Demographics

Taking into consideration the inclusion criteria of this study, 45 patients could be evaluated. Most of the patients (62% [n = 28]) were of the male sex. The age range of the patients was between 13 and 75 years, with a mean age of 36 years. None were edentulous, 56% (n = 25) had partial dentition, and 38% (n = 17) had no tooth loss; wisdom teeth were not included in the observable dentition, and no data were present for 3 patients (7%). The 3 most common etiologic factors were falls (27% [n = 12]), motor vehicle crashes, and violence (each 16% [n = 7]). In almost 10% (n = 4), no information about the etiology could be gathered. Gunshot injuries were not found to be the cause of any of the fractures in this study. An overview of these results is shown in Figure 1. Mean age was older than 30 years for all the etiologic factors besides suicidal falls, where the mean age was younger than 20 years.

Substance abuse was a relatively common finding in this study population. Tobacco smoking was seen in 36% (n = 16; missing data in 40%) of the patients, alcohol abuse was seen in 20% (n = 9; missing data in 40%), and illicit street drug use was seen in 16% (n = 7; missing data in 44%).

Associated injuries were common in the head and neck region as well as in other areas of the body.

Treatment

In 20%, the comminuted fracture site extended over several mandibular areas; otherwise, the comminution was located in the paramedian region of the mandible (47% [n = 21]), the body (13% [n = 6]), the angle (9% [n = 4]), the symphysis (7% [n = 3]), or the condylar process (4% [n = 2]). No other regions were affected.

FIGURE 2. Three-dimensional CT reconstruction of the comminuted fracture.

The operation time ranged from 1 to 7 hours, with a mean of 3.3 hours and a median of 3.1 hours. In 60% of the cases (n = 27), mandibulomaxillary fixation (MMF) was only in place during the operation. Duration of MMF ranged from zero to 28 days, with a mean of 4.8 days. In 33 patients (73%), MMF was performed with a continuous wire loop splint or with arch bars; and in 10 patients (22%), intermaxillary screws were used.

Postoperative Treatment and Complications

Hospitalization ranged from 2 to 36 days, with a mean time of 10 days and a median of 7 days. The follow-up time was at least 12 months. Patients were signed off work for a mean of 25 days, with a range from 6 to 49 days.

Postoperative complications were seen in 7 patients or 16% of the whole study population. These 7 patients had the following complications: wound dehiscence (7% [n = 3]), osteomyelitis (7% [n = 3]), abscess development (4% [n = 2]), bone necrosis (2% [n = 1]), and severe nonocclusion (2% [n = 1]).

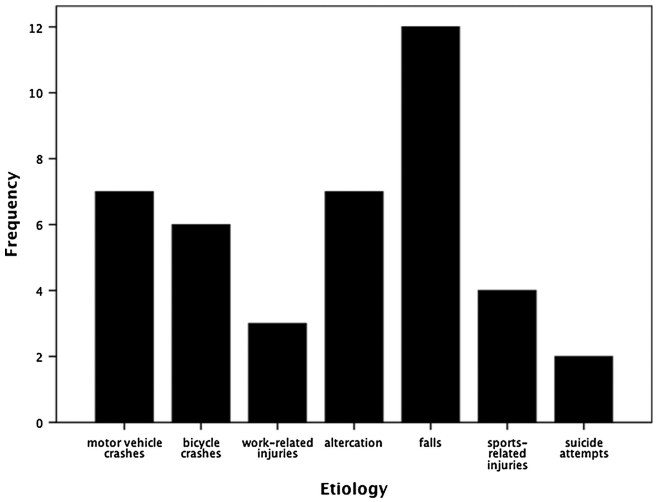

FIGURE 1. Different etiologic factors for comminuted mandibular fractures.

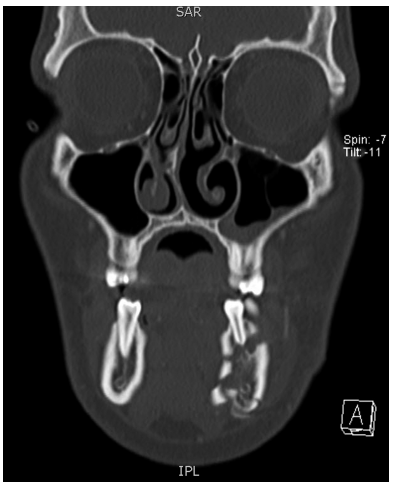

FIGURE 3. Coronal view showing the degree of comminution.

FIGURE 4. Axial view showing the degree of comminution.

Clinical Examples of the Study

Two patients of the study population were selected to show clinical examples. The images resemble the kind of comminuted mandibular fractures that were included in this study. Figure 2 shows the preoperative 3-dimensional reconstruction computed tomographic (CT) scan. Figures 3 and 4 show the coronal and the axial CT scan of the same patient, and Figure 5 demonstrates the postoperative x-ray. The other patient's preoperative CT scan is shown in Figure 6, whereas postoperative plate positioning is shown in Figure 7.

DISCUSSION

Comminuted mandibular fractures are the result of high-velocity or high-impact trauma, which is not typically seen in traditional mandibular fractures. Several treatment options exist, from closed reduction with external fixation to open reduction with internal fixation. Each technique possesses its own advantages and disadvantages. Although a thorough review of the literature was performed, a study evaluating the outcome of comminuted mandibular fractures treated by ORIF using an intraoral approach could not be found. Therefore, this present study was designed to retrospectively analyze the outcome of comminuted mandibular fractures using an intraoral approach.

Comminuted mandibular fractures are usually accessed by an extraoral approach if the facture is treated by ORIF. This access provides excellent visualization, and the mandibular bone can be accessed from the buccal, the lingual, and the caudal directions, which allows proper reposition and plate fixation. Because an incision at the lateral neck is made to access the mandibular bone, several important structures are endangered: the marginal mandibular branch of the facial nerve, the lingual and the hypoglossal nerve, the facial vessels, and the submandibular and parotid glands.[8–12]

FIGURE 5. Postoperative Panorex illustrating plate positioning.

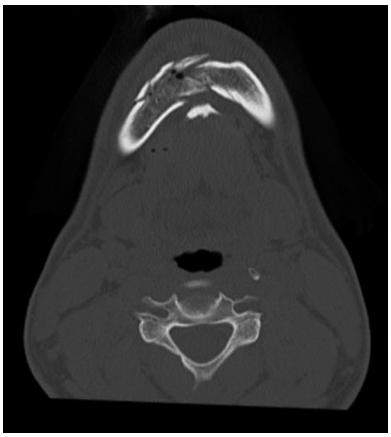

FIGURE 6. Preoperative axial CT scan to analyze the degree of comminution.

Damage to any of these structures may result in severe and permanent functional or aesthetic consequences.

The intraoral approach is an alternative to the extraoral approach and is commonly used to treat noncomminuted mandibular fractures. This approach will result in no external scarring and poses a lower risk for injury to the facial nerve while still allowing direct visualization of the fracture.[14] However, disadvantages exist: visualization is reduced compared to the extraoral approach, lingual bone fragments cannot be realigned, and oral bacteria contaminate the fracture.[15] Further postoperative mental nerve hypoesthesia is a common complication. The mental nerve may be strained or, worse, may be accidentally injured. When making the intraoral incision, special attention has to be paid to the mental nerve. Because comminuted mandibular fractures result from a high force, the inferior alveolar nerve is at an increased risk for being damaged during the initial trauma. In fact, Bede et al[16] published inferior alveolar nerve injury rates of almost 82% in comminuted mandibular fractures. Given the severity of the initial trauma, mental nerve hypoesthesia can be rated as a minor complication. Furthermore, the prognosis is usually good. Bede et al[16] reported a recovery rate of 91% for the inferior alveolar nerve.

Aside from the intraoral incision, a small incision into the cheek is usually necessary to allow placement of distal screws. However, this transbuccal incision carries a small risk of damage to adjacent nerves, vessels, and the parotid gland, although the

FIGURE 7. Postoperative x-ray demonstrating plate positioning.

review of literature and the experience of this study show that this is a very rare to negligible complication.[17–19]

Comminuted mandibular fractures tend to have a worse outcome with a prolonged recovery time, and postoperative inflammatory complications are common.[20,21] The intraoral approach is another risk factor for increasing the inflammatory complication rate, since the fracture will become exposed to oral bacteria. To decrease this risk, it is important to administer preoperative antibiotics and chlorhexidine mouth rinse. Prophylactic antibiotics have the potential to reduce the risk for postoperative infections from 42.2% to 8.9%.[22] Further risk factors that are associated with postoperative inflammatory complications are prolonged operation time.[20] Longer operative time also leads to prolonged time under general anesthesia. Boruk et al[23] demonstrated a strong positive correlation between the time under general anesthesia for major head and neck surgery and increased risk factors for complications. Taking the results of these publications into consideration, it is of high importance to keep the operating time as short as possible. One might think that treating this kind of fracture only with an intraoral approach extends operative time. Kale et al. compared the extraoral and transbuccal approach for treating mandibular fractures and reported shorter operating time with the transbuccal approach.[14] Toma et al[15] compared the operative time between the extraoral and the intraoral approach for mandible fractures and published only a slightly longer duration for the intraoral method. The mean operation time in this study for comminuted mandibular fractures using the intraoral approach was 3.3 hours, with the time to establish the MMF already included. Associated facial injuries were common and were treated surgically if needed, which further extended the operation time. Therefore, it can be stated that anesthesia-related complications will not be increased owing to this operating technique. However, since visualization is more difficult with the intraoral approach, experience in this surgical method is mandatory that operative time will not become extended.

Whereas costs can be reduced significantly when mandibular fractures are treated only with MMF,[24] one cannot deny the advantage of the needlessness of prolonged MMF. Mandibulomaxillary fixation can be opened directly after the surgery in most cases when ORIF is performed, allowing the patient to eat soft foods just shortly after the operation. Mandibulomaxillary fixation may have to be maintained with elastics to adjust occlusion postoperatively. Patients will appreciate that masticatory function is reestablished shortly after the surgery, as opposed to the conservative treatment of MMF, which consists of weeks on a liquid diet. Ellis[7] reports that accurate reduction of the fracture, avoidance of MMF with a shorter recovery time, timely rehabilitation, and increased patient's comfort can be achieved using an intraoral approach. Further disadvantages of treating fractures solely with MMF are jaw immobility, dietary restriction, reduced oral hygiene, especially lingually, and transient periodontal damage.[25]

In the following paragraphs, the complications and the outcome of this study shall be discussed.

Excellent postoperative outcome was seen in 84% (n = 38) and was defined by absence of severe complications, absence of mental nerve anesthesia, intact facial nerve function, interincisor gap of more than 40 mm at the last follow-up, presence of reproducible and stable occlusion at the last follow-up, and patient's satisfaction.

Postoperative complications were seen in 7 patients (16%). This relatively high percentage might be explained owing to the severe initial trauma and that comminuted fractures tend be difficult to treat with high complication rates as previously stated. Furthermore, the study population had a high rate regarding nicotine, drug, and alcohol abuse. One might consider if such patients should be treated by the extraoral approach since these patients have a higher complication rate.

Our results show that the intraoral incisions generally healed well, and in the cases where wound dehiscence occurred, it could be treated without further invasive methods. No edentulous patients were in the study population, but the intraoral incision could cause scarring that may lead to changes in the vestibular mucosa and the gingiva of the alveolar ridge. Therefore, it may be necessary to adapt the dentures once the incisions are healed.

The present study, using the intraoral approach for ORIF, reveals great results regarding healing and hospitalization time. Most patients could be discharged from the hospital shortly after the operation and were able to return to work soon.

Our hypothesis that the intraoral access is a highly valuable alternative to the extraoral approach was supported by the outcome. The reduction and the internal fixation provided high-quality results. Pretraumatic occlusion could be established in most cases. Patient's satisfaction regarding the postoperative results was high. With these factors in mind, the intraoral approach may have many advantages over the extraoral technique.

Weaknesses of this study include the small study population and the retrospective analysis method used. Another weakness is that the statistical analysis did not find any significant relations between the complication rate and the outcome with the collected data of this study, such as how long MMF was in place. To establish such correlations, the study population must be increased; but comminuted mandibular fractures are not seen as frequently at the site of the study as at other maxillofacial departments. Furthermore, the researchers decided to establish strict inclusion and exclusion criteria, which further lowered the study population. On the other hand, the well-defined criteria ensured that only comminuted fractures were included, as the primary goal of the study was to decide whether the intraoral approach is a good alternative to the extraoral technique.

Future prospective studies with larger study populations are needed to fully assess the outcome of comminuted mandibular fractures treated with an intraoral approach. It could be beneficial to include injury severity scores like the Mandible Injury Severity score published by Shetty.[26] It is further suggested that a treatment protocol is established and consistent follow-ups are scheduled within 1 year. Since this is a retrospective study, the clinical findings could only be evaluated from patients' charts; it would be more beneficial to gather the required variables pre operatively and postoperatively so that the amount of missing data can be reduced. Furthermore, it was difficult to establish outcome criteria retrospectively. With a prospective study, the outcome criteria can be monitored and the patient satisfaction could be evaluated with a questionnaire since this is another important factor of the outcome.

The intraoral approach represents a useful and safe operation technique for comminuted mandibular fractures and has several advantages for patients and surgeons. The outcome of fractures treated by this approach can be of better nature as with the extraoral approach. Nevertheless, each case has to be judged on its own accord as to which technique can best treat the underlying fracture.

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